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Forest Health Protection

Pacific Southwest Region

Northeastern California Shared Service Area

Date: December 1, 2017
File Code: 3420

To: District Ranger, Feather River Ranger District, Plumas National Forest

Subject: Evaluation of stand conditions in the Challenge Community Protection Project (FHP Report NE17-07)

At the request of Clay Davis, District Planner, and Ken Neeley, Forester, Feather River Ranger District, Danny Cluck, Forest Health Protection (FHP) Entomologist, visited the Challenge Community Protection Project with district staff on September 18, 2017. The objective was to evaluate the current forest health conditions within the project area, discuss what influence these conditions would have on stand management objectives and provide recommendations as appropriate. Clay Davis, Ken Neeley and Erik Apland, Forestry Technician (Fuels), accompanied me to the field.

Key findings:

- Ponderosa pine plantations are overstocked and experiencing elevated levels of tree mortality caused by western pine beetle, including those found within the Challenge Experimental Forest.
- Native mixed conifer stands have also experienced elevated levels of ponderosa and sugar pine mortality caused by western pine beetle and mountain pine beetle.
- High stand density is putting many forests around the community of Challenge at risk to high levels of bark beetle-caused tree mortality during future droughts.
- Ponderosa pine plantations and native mixed conifer stands are at risk to moderate to high severity wildfire due to due crowded stand conditions, accumulating dead and down course woody debris from bark beetle-caused tree mortality and a high density of understory trees.
- Thinning, mastication and prescribed fire are highly recommended throughout the project area to reduce tree density and surface and ladder fuel levels. Specific recommendations are provided in this evaluation.

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Description of the project area

The Challenge Community Protection Project (CCPP) is located around the community of Challenge, CA at elevations ranging between 2,300 and 3,500 feet (39.486810N and 121.223371W). Annual precipitation ranges between 50 and 70 inches (Figure 1). Most of the area is comprised of Sierra mixed conifer consisting of Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), sugar pine (*Pinus lambertiana*), incense cedar (*Calocedrus decurrens*), California black oak (*Quercus kelloggii*), Pacific madrone (*Arbutus menziesii*), and tanoak (*Notholithocarpus densiflorus*). Ponderosa pine dominated stands are found on south and west facing slopes, ridgetops and drier valley bottoms often mixed with black oak, incense cedar and Douglas-fir. The project area also includes large, 55-65 year old ponderosa pine plantations.

Project objectives

The CCPP proposes to reduce hazardous fuels and reduce the risk of insect and disease-caused tree mortality through mechanical and hand thinning, mastication of brush and prescribed burning. Ponderosa pine plantations will be thinned to approximately 80-120 sq. ft./acre of basal area emphasizing stand variability. Mixed conifer stands will retain relatively higher stocking, especially in California spotted owl habitat, but emphasize the reduction of dense groups of ponderosa pine, California black oak release and removing smaller diameter trees from the understory. The residual stands will be more open, increasing the amount of available soil moisture and sunlight for individual trees. Hazard trees will be identified and removed along all roadways.

Forest insect and disease conditions

Agents/hosts observed during this site visit:

- High levels of western pine beetle (*Dendroctonus brevicomis*)-caused mortality of ponderosa pine (Figure 1)
- Top-killing of ponderosa pine by California fivespined ips (*Ips paraconfusus*)
- California flatheaded borer (*Phaenops californica*) in previously California fivespined ips top-killed ponderosa pine
- Mountain pine beetle (*Dendroctonus ponderosae*)-caused mortality of sugar pine
- Red ring rot (*Porodaedalea pini*) in Douglas-fir

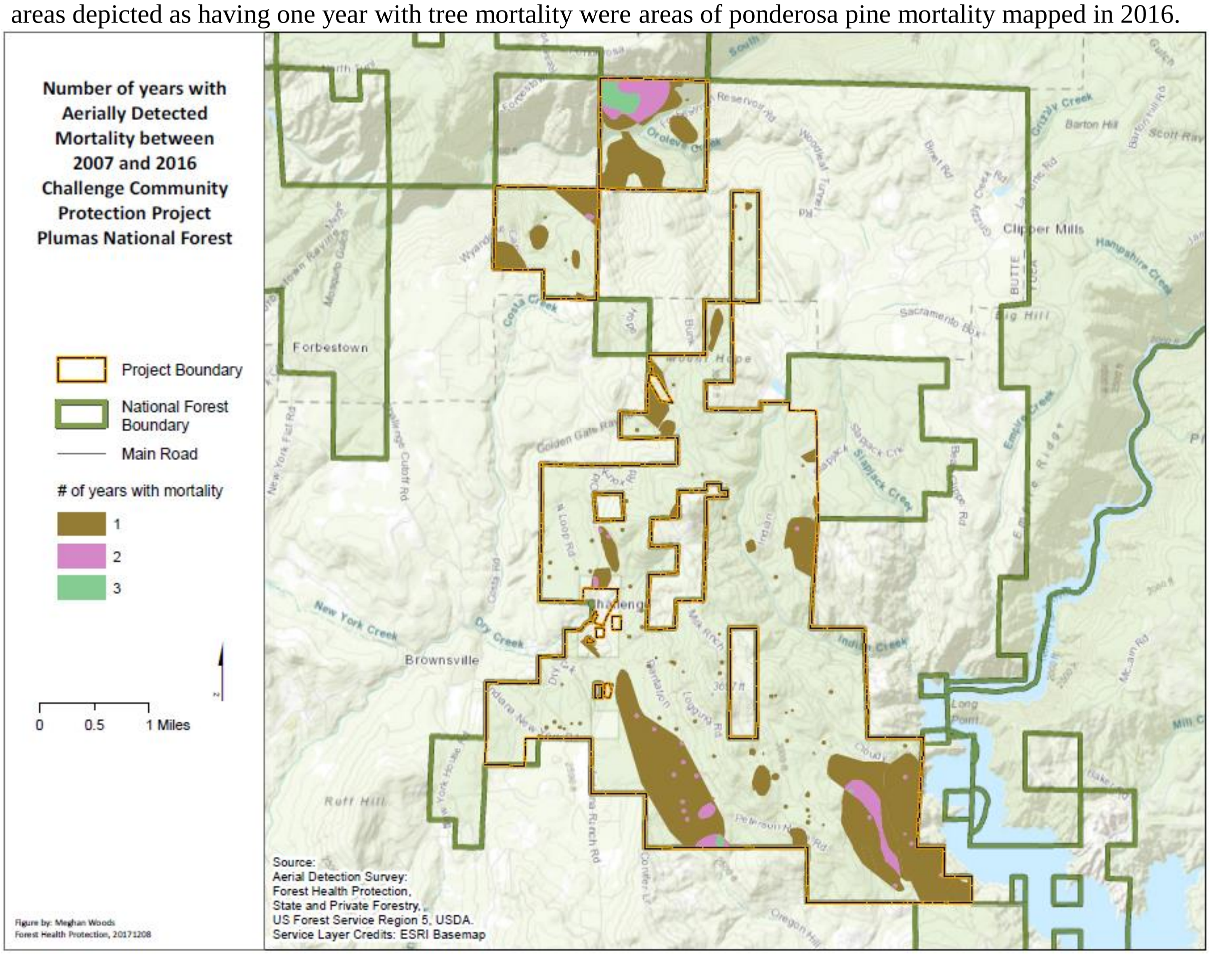
Figure 1. Dense ponderosa pine plantation with western pine beetle-caused mortality.

Stand conditions and tree mortality related to recent and future climate trends

Most of the forested areas in the CCPP are in an overstocked condition and experienced an elevated level of tree mortality caused by bark beetles during the recent drought (Table 1 and Figures 2 and 3). Aerial detection surveys identified a sharp increase in mortality for the project

Figure 2. Dense mixed conifer stand adjacent to Challenge with dead and dying ponderosa and sugar pine. Google imagery date of 6/29/2017.

Figure 3. Areas with tree mortality mapped by Aerial Detection Surveys (ADS) between 2007 and 2016. Most areas depicted as having one year with tree mortality were areas of ponderosa pine mortality mapped in 2016.



area during 2016 after the extremely dry water year of 2014 and 2015. Elevated levels of bark beetle-caused tree mortality in the project area, as well as in the rest of the Sierra Nevada range, are strongly associated with periods of below normal precipitation and high stand density. This mortality combined with the existing high stand density has resulted in heavy fuel loading in some areas and a corresponding increase in the risk of stand replacing wildfire (Figure 4).

Figure 4. Dead and down bark beetle-killed ponderosa pine mixed with dense understory vegetation.

Predicted climate change is likely to impact trees growing in this area over the next 100 years. Although no Plumas National Forest specific climate change models are available at this time, there is a general consensus among California models that summers will be drier than they are currently. This prediction is based on the forecasted rise in mean minimum and maximum temperatures and remains consistent regardless of future levels of annual precipitation (K. Merriam and H. Safford, *A summary of current trends and probable future trends in climate and climate-driven processes in the Sierra Cascade Province, including the Plumas, Modoc, and Lassen National Forests*). Under this scenario, the risk of bark beetle-caused tree mortality will likely increase for all conifer species, especially high concentrations of larger (>8" DBH) ponderosa pine growing on these low elevation, warmer sites (Figure 5).

Figure 5. Dense ponderosa pine plantation that is highly susceptible to western pine beetle-caused mortality.

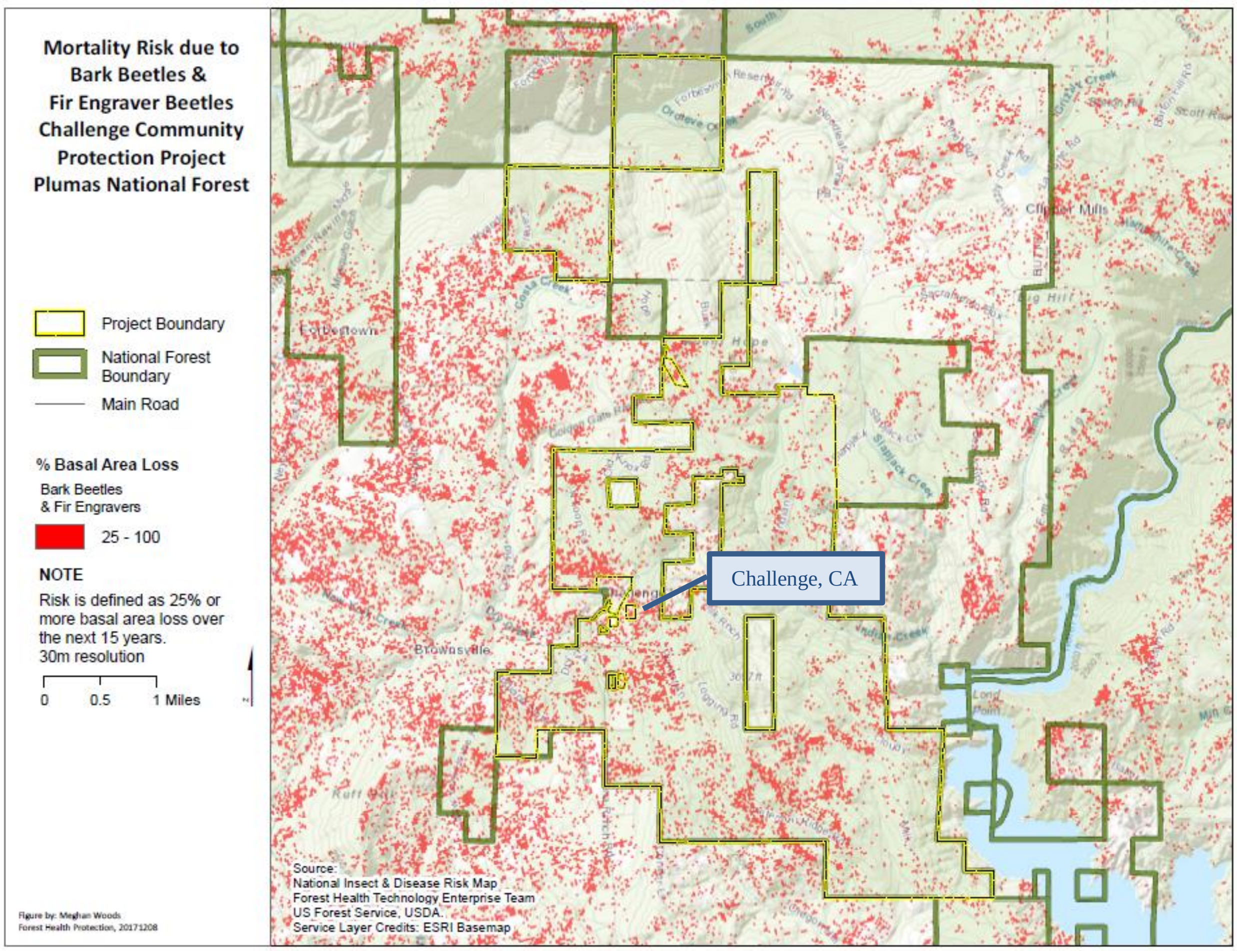
Table 1. Acres with tree mortality, estimated dead trees per acre, estimated total # of dead trees from R5 Aerial Detection Surveys and Palmer Hydrologic Drought Index (PHDI) (CA Division 2) by water year (Oct-Sept) within the CCPP.

Year	Acres	Dead Trees/Acre	Total # of Dead Trees	PHDI[1]
2016	**1,412**	**3.3**	**4,614**	-1.74
2015	111	1.9	212	-3.02
2014	29	1.2	34	-3.12
2013	269	1.6	422	-1.62
2012	56	10.2	570	0.37
2011	1	1.4	1	2.59
2010	144	1.0	146	0.19
2009	19	5.5	103	-2.69
2008	2	3.9	7	-2.74
2007	3	8.2	24	-2.74

[1] Palmer drought values show a relationship to tree mortality. PHDI values ranging from -2.00 to -2.99 are considered moderate drought conditions. Severe drought conditions range from -3.00 to -3.99 and extreme drought conditions are below -4.00.

The most recent National Insect and Disease Risk Map (2012) show many stands within and adjacent to the CCCP that are currently at risk to high levels of bark beetle-caused mortality (Figure 6). Improving the resilience of stands to future disturbance events through density, size class and species composition management will be critical to maintaining a healthy forested landscape around the community of Challenge.

Figure 6. Risk of bark beetle-caused tree mortality based on precipitation, stand density and average diameter (Region 5 Forest Insect and Disease Risk Map 2012 version).



Discussion and recommendations

Ponderosa pine mortality caused by western pine beetle is the primary threat to forest health in the CCPP second only to wildfire. Ponderosa pine growing in this area is at a much higher risk to mortality than the other conifers due to its higher density (especially in plantations), clumpy distribution and susceptibility to an aggressive bark beetle species that has the ability to build up large populations over a short time period in response to drought. Therefore, ponderosa pine should be given special consideration when planning thinning treatments to reduce its susceptibility to successful western pine beetle attacks. In native mixed conifer stands, susceptibility could be decreased by reducing density to lower levels in ponderosa pine dominated pockets (<120 sq.ft./acre recommended) than what is appropriate for surrounding mixed conifer stands and/or by removing more ponderosa pines from these pockets in favor of retaining other tree species to increase diversity. Including the removal of suppressed individuals as well as any bark beetle infested trees will improve the efficacy of treatments. Sufficiently

lowering the basal area in pine dominated pockets may reduce their canopy cover to below required thresholds. However, more basal area, and higher canopy cover, could be retained in adjacent mixed conifer areas in order to maintain a higher average throughout a stand.

For native ponderosa pine dominated stands and ponderosa pine plantations, stocking is well above the limiting stand density index (SDI) of 365. SDI 365 is considered the upper management zone for ponderosa pine above which bark beetle outbreaks are likely to occur (Oliver 1995).

High stand density combined with drought conditions cause extreme moisture stress in individual trees, thus reducing their ability to fend off bark beetle attacks. Healthy ponderosa pines defend themselves by producing resins that drown attacking beetles. When trees are stressed, resin pressure is reduced and the probability of successful bark beetle attack is increased. High stand density may also improve conditions for the bark beetle pheromone communication system, which facilitates mass attacks on individual trees and groups of trees, by concentrating the pheromone plume under a full canopy.

The best strategy to decrease the amount of mortality in the long-term is to reduce stand density through thinning. Thinning will increase the health and vigor of residual ponderosa pines by reducing competition for limited soil moisture (Fettig et al. 2007). The District should consider reducing the SDI in ponderosa pine dominated stands to below 230. SDI 230 is the defined threshold for the zone of imminent bark beetle caused mortality. Within this zone, endemic populations kill a few trees but net growth is still positive (Oliver 1995). Thinning stands to this level will reduce the risk of additional bark beetle-caused mortality by reducing tree competition for limited water and nutrients.

Dense ponderosa pine plantations would benefit by the same reductions in stand density with an emphasis placed on creating spatial heterogeneity and enhancing conditions for other tree species such as Douglas-fir, incense cedar and black oak. Thinning prescriptions should aim to reduce basal area to a range of 60 to 120 sq.ft./acre. This should effectively reduce the risk of significant western pine beetle-caused mortality.

Lowering density in ponderosa pine stands will not only increase the health and vigor of individual trees but may serve to change the microclimate, creating a less favorable environment for bark beetle pheromone communication. Opening up the canopy creates convection currents and air turbulence through increases in soil temperature as well as increasing wind speed (Bartos and Amman 1989, Amman and Logan 1998). This prevents bark beetle pheromone plumes from concentrating under the canopy and remaining in close proximity to individual trees or groups of trees.

When planning thinning treatments, it should be recognized that the target stand density is an average to be applied across the landscape and some variability may be desired. Individual high value trees, such as large mature pines and black oaks, should benefit by having the stocking around them reduced to lower levels. Areas of pure or nearly pure ponderosa pine would also benefit from lower stocking levels as well as an increase in species diversity. Allowing for denser tree spacing and pockets of higher canopy cover may be desirable around potential wildlife trees, such as forked and/or broken-topped trees, or on more mesic north-facing slopes. Incorporating the concepts of GTR 220 will address many of these issues and be consistent with

Regional ecosystem restoration goals. Many of these methods are also consistent with past FHP recommendations for thinning in mixed conifer stands and their use is supported for the CCPP.

Sugar pine should be retained as much as possible during any thinning operation in order to preserve genetic diversity, especially white pine blister rust (*Cronartium ribicola*) resistant individuals. An exception to this would be thinning suppressed trees within pure sugar pine groups to reduce inter-tree competition. White pine blister rust, a non-native pathogen, has continued to weaken and kill this species over most of its range since its introduction into the Pacific Northwest in 1910. Identification and protection of local rust resistant trees for seed collection, if not already occurring, will aid in the future planting of rust resistant seedlings. Planting selected openings created through thinning operations with rust resistant stock would help insure this species persists in the area.

It is recommended that a registered borate compound be applied to all freshly cut conifer stumps >14" dbh to reduce the chance of creating new infection centers of *Heterobasidion irregulare* (formerly 'P'-type annosus root disease) and *H. occidentale* (formerly 'S'-type annosus root disease) within the unit. Although no signs of Heterobasidion root disease were observed and root disease is not typically a problem in this area, an extensive road network and high use by the local community creates a situation where minimizing the number of hazard trees becomes more important. Treating stumps will reduce the chance of creating new infection centers that could lead to the creation of future hazard trees.

Considerations for Rx fire

If prescribed fire is used as a follow-up treatment to stand thinning, it may result in unacceptable levels of tree mortality; depending on management objectives. This mortality most often occurs as a direct result of cambium or crown injury to individual trees during the fire. Mature ponderosa and especially sugar pines are susceptible to lethal basal cambium damage during prescribed burns from the heat that develops in the deep duff and litter that accumulates at their bases. These duff mounds typically burn at a slow rate with lethal temperatures, causing severe injury to the cambium which girdles the trees. To protect individual high-value large diameter pine from lethal cambium damage, raking the duff away from the bases of these trees before burning (within 24" of the bole and down to mineral soil) is recommended.

Considerations for hazard trees

Identification and removal of hazard trees within the project area should take into account the type of target that may be impacted by a tree failure. Targets such as lower use Forest Service system roads may not require the same level of hazard tree removal as high use, paved county roads or adjacent private property, including structures. The Region 5 hazard tree guidelines (Angwin et al 2012) provide information to help land managers determine what type of hazard trees should be addressed and specific criteria for identification. The use of these guidelines is highly recommended for the CCPP. Forest Health Protection can also assist with hazard tree field training for marking crews.

Potential for funding thought the Western Bark Beetle Program

Forest Health Protection may be able to assist with funding for thinning and removing green material from overstocked areas within the CCPP area. Thinning treatments that reduce stand

density sufficient to lower the risk to bark beetle-caused mortality would meet the minimum requirements for Western Bark Beetle Program funding and would be supported by this evaluation. If you are interested in this competitive funding please contact me for assistance in developing and submitting a proposal.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431.

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Bark beetle information

Western Pine Beetle

The western pine beetle, *Dendroctonus brevicomis*, has been intensivly studied and has proven to be an important factor in the ecology and management of ponderosa pine thoughout the range of the host species (Miller and Keen 1960). This insect breeds in the main bole of living ponderosa pine larger than about 8 inches DBH. Normally it breeds in trees weakened by drought, overstocking, root disease, dwarf mistletoe or fire. Adult beetles emerge and attack trees continuously from spring through fall. Depending on the latidude and elevation, there can be from one to four generations per year.

Evidence of Attack

Initial attacks are made about mid-bole and subsequent attacks fill in above and below. Pitch tubes are formed on the tree trunk around the entry holes. Successful pitch tubes are red-brown masses of resin and boring dust. Relativly few, widely scattered white pitch tubes usually indicate that the attacks were not successful and that the tree should survive. Pheremones released during a successful attack attract other conspecifics. Attracted beetles may then spill over into nearby apparently healthy trees and overwhelm the tree with sheer numbers.

Life Stages and Development

These beetles pass thorugh the egg, larval, pupal and adult stages during a life cycle that varies in length dependent primarily on temperature. Adults bore a sinuous gallery pattern in the phloem and the female lays eggs in niches along the sides of the gallery. The larvae are small white grubs that first feed in the phloem then mine into the middle bark where they complete most of their development. Bluestain fungi inoculates the tree during successful attacks, blocking trachids and vessicles which contribute to the rapid tree mortality associated with bark beetle attacks.

Conditions affecting Outbreaks

Outbreaks of western pine beetle have been observed, and surveys made, in pine regions of the Westsince 1899 (Hopkins 1899; cited in Miller and Keen 1960). An insect survey completed in 1917 in northern California indicated that over 25 million board feet of pine timber had been killed by bark beetles.Information from surveys conducted in the 1930's indicated enormous losses attributed to the western pine beetle around that time. During the 1930's outbreak, most of the mortality occurred in stands of mature or overmature trees of poor vigor (Miller and Keen 1960). Group kills do not typically continue to increase in size though successive beetle generation as is typical with Mountain Pine Beetle and Jeffreay Pine Beetle. Rather, observations indicate that emerging beetles tend to leave the group kill area to initiate new attacks elsewhere.

The availability of suitable host material is a key condition influencing western pine beetle outbreaks. In northeastern California, drought stress may be the key condition influencing western pine beetle outbreaks. When healthy trees undergo a sudden and sever moisture stress populations of western pine beetle are likely to increase. Healthy trees ordinarily produce abundant resin, which pitch out attacking beetles, but when deprived of moisture, stressed trees cannot produce sufficient resin to resist the attack. Any condition that results in excessive demand for moisture, such as inter-tree completion, competing vegetation, or protracted drought periods; or any condition that reduces the ability of the roots to supply water to the tree, such as mechanical damage, root disease or soil compaction, can cause moisture stress and increase susceptibility to attack by the western pine beetle. Woodpeckers, predacious beetles, and low temperatures act as natural control agents when beetle populations are low (endemic populations).

Mountain pine beetle

The mountain pine beetle, *Dendroctonus ponderosae*, attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 8 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

Evidence of Attack

The first sign of beetle-caused mortality is generally discolored foliage. The mountain pine beetle begins attacking most pine species on the lower 15 feet of the bole. Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes on successfully infested trees are pink to dark red masses of resin mixed with boring dust. Creamy, white pitch tubes indicate that the tree was able to "pitch out" the beetle and the attack was not successful. In addition to pitch tubes, successfully infested trees will have dry boring dust in the bark crevices and around the base of the tree. Attacking beetles carry the spores of blue-staining fungi which develop and spread throughout the sapwood interrupting the flow of water to the crown. The fungi also reduces the flow of pitch in the tree, thus aiding the beetles in overcoming the tree. The combined action of both beetles and fungi causes the needles to discolor and the tree to die.

Life Stages and Development

The beetle develops through four stages: egg, larva, pupa and adult. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is typical, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine. Females making their first attacks release aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. The adults bore long, vertical, egg galleries and lay eggs in niches along the sides of the gallery. The larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.

Conditions Affecting Outbreaks

The food supply regulates populations of the beetle. In lodgepole pine, it appears that the beetles select larger trees with thick phloem, however the relationship between beetle populations and phloem thickness in other hosts has not been established. A copious pitch flow from the pines can prevent successful attack. The number of beetles, the characteristics of the tree, and the weather affect the tree's ability to produce enough resin to resist attack. Other factors affecting the abundance of the mountain pine beetle include nematodes, woodpeckers, and predaceous and parasitic insects. As stand susceptibility to the beetle increases because of age, overstocking, diseases or drought, the effectiveness of natural control decreases and pine mortality increases.